Steam ESA 240-2_Kraft Foods Global Inc. Dover, DE
Public Report - Final

Company	Kraft Foods Global Inc.	**ESA Dates**	December 10th to 12th
Plant	Dover, Delaware	**ESA Type**	Steam
Product	Prepared food goods	**ESA Specialist**	Tom Tucker, P.E.

Brief Narrative Summary Report for the Energy Savings Assessment:

Introduction:
On behalf of the Department of Energy, Tom Tucker of Kinergetics LLC conducted a steam system ESA at the Kraft Foods Global Inc. facility in Dover, Delaware from December 10th to 12th, 2007. The ESA and training activities were provided through the United States Department of Energy-Save Energy Now initiative, which was established to help the largest natural gas users in the United States identify ways to reduce energy use.

Because steam is purchased from an adjacent cogeneration facility for approximately 11 months of the year, no boiler specific opportunities are addressed. The facility was assumed to operate approximately 8,000 hours per year for all calculations performed.

Steam Pricing
The cost for steam was reviewed using 2006 utility data. The marginal cost of steam, also included on the summary, was reviewed and identified. The marginal cost is near or slightly above average when using natural gas as a boiler fuel, but is high when coal is used as a fuel. While it is understood that the cogenerated price of steam is "fully loaded," the Kraft Foods Global Inc. facility maintains a full staff and the boiler must also be inspected and maintained annually, so it appears that under the current pricing scenario, once all factors are considered, the steam cost may actually be higher than possible if the facility boilers are used.

Given the high cost of electricity also being paid by the facility, a closer look at contract steam prices, options for boiler operation, and onsite cogeneration are worth consideration and are discussed below.

Steam System
The facility uses steam at 175-psig and 35-psig to meet process and HVAC steam requirements. High pressure process steam condensate is sent to flash vessels and then returned to the DA tank in the boiler room using a steam-powered condensate pump (Liqui-Mover). The DA tank serves as a condensate storage tank when the faculty steam system is not in use.

In addition to the DA tank, the "reactor vessel" in the boiler room also serves as a water storage vessel to balance out condensate pumping back to the cogeneration facility. The reactor tank is steam blanketed to prevent freezing since a portion of the tank protrudes above the roof line.

Objective of ESA:
The primary objective of the ESA was to identify steam cost reduction opportunities and to have the primary ESA lead become comfortable with the use of the DOE steam tools.

Focus of Assessment:
SSAT was applied to model cost reduction opportunities identified during walk-throughs and group discussions, with particular attention given to the steam venting issues. Additionally, assistance was provided to address trap sizing and piping design issues that may be contributing to valve flange gasket failures.

Approach for ESA:
The ESA started with an introduction and a brief Power Point presentation introducing the different steam tools. The Steam System Scoping Tool (SSST) was completed during the assessment. Scores above 75-percent are considered very good and scores below 55-percent indicate opportunity for improvement.

General Observations of Potential Opportunities:
Below are brief descriptions of each opportunity evaluated. Each opportunity has been rated based on the following definitions:

1. Near term opportunities: Include actions that could be taken as improvements in operating practices, maintenance of equipment or relatively low cost actions or equipment purchases.
2. Medium term opportunities: Require purchase of additional equipment and/or changes in the system such as addition of recuperative air pre-heaters and use of energy to substitute current practices of steam use etc. It would be necessary to carryout further engineering and return on investment analysis.
3. Long term opportunities: Require testing of new technology and confirmation of performance of these technologies under the plant operating conditions with economic justification to meet the corporate investment criteria.

1. Consider a Gas Combustion Turbine for Cogeneration (medium term)
As mentioned previously, it appears the existing steam contact price may be somewhat unfavorable towards Kraft Foods Global Inc. and options are recommended for cost reduction. However, when the gas used in 2006 for the facility boilers is included with the imported steam cost, the weighted average or "impact" marginal steam cost drops. Since most facility boiler gas use occurred during periods when the gas price was higher, if monthly cost is considered, the cost per 1,000-lbs would be lower. One option is the use of a gas combustion turbine fitted with a heat recovery steam generator (HSRG) to generate process steam on site. A few characteristics of combustion turbines are:

- Efficiencies from 25% to 40% for smaller simple cycle configurations and 40% to 60% for larger combined cycle configurations.
- Combustion air temperature has a significant impact on generation efficiency (cooler is better).
- Relatively quiet operation.
- Installed cost of approximately $1,200/kW to $2,000/kW with heat recovery;
- Maintenance costs of $0.002/kWh to $0.008/kWh.

Preliminary review of 2006 utility data indicates that on-site power generation is a viable option to consider for long term-planning. Load profiles for facility steam and electricity were developed to assist with the preliminary analysis and suggest a continuous power output of approximately 1,200-kW (25-percent generation efficiency) to match the *base* annual steam demand requirement of 6,259-pph is feasible. The base steam demand is the minimum average steam flow for 8,000 hours per year. Because the annual average steam demand is estimated at approximately 16,400-pph, the on-site boiler can be used to provide the difference of:
16,400-pph – 6,259-pph = 10,141-pph

Economic Assessment
Steam is presently purchased from an adjacent cogeneration facility and it was first necessary to estimate the "effective" boiler efficiency. This is the boiler efficiency that would result in the present steam cost *if* the facility boiler was being used to generate steam.

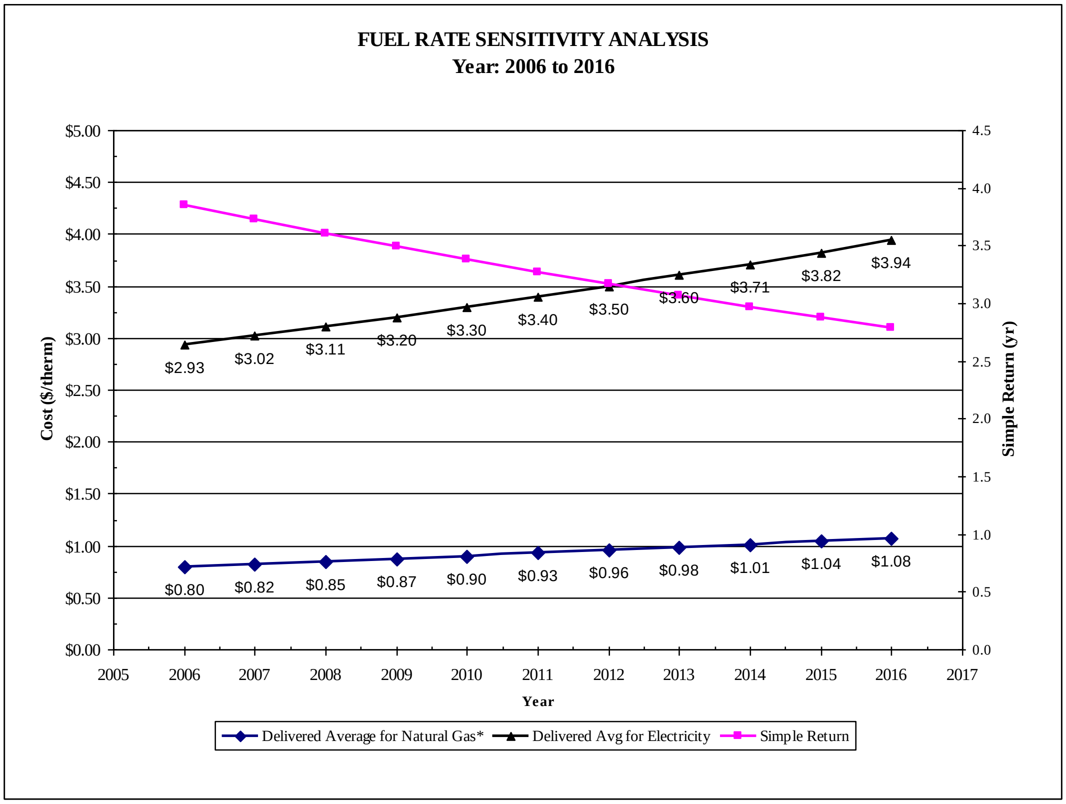
As mentioned previously, the cost of the cogenerated steam is fully burdened with labor, maintenance and any incidental costs incurred by the cogeneration plant. However, the man-power is already present on-site at Kraft Foods Global Inc. to address boiler house operation and given the experience of those present, it is assumed that addition of on-site power *would not* require additional personnel. It appears that Kraft Foods Global Inc. is paying twice for labor and this is included in the "effective" boiler efficiency.

Full time use of the boiler would increase incidental cost (water treatment, etc) and maintenance may go up some but because the boiler is already kept in operating condition, the majority of maintenance cost is likely already paid by Kraft Foods Global Inc. As a result, the effective efficiency is based on 95-percent of the 2006 cogenerated steam cost. Considering the above, the effective boiler efficiency is 64.5-percent and is the value used in assessment of gas turbine potential.

Figure 1 summarizes the economic performance for installation of a 1,200-kW combustion turbine and HRSG based on escalated fuel and electricity trends and assuming that energy costs increase at a rate of 3-percent per year. The following assumptions were made to generate **Figure 1**:

- ➢ The fuel cost to provide 1,200-kW and the base load steam (6,259-pph) for 8,000 hours per year.

Figure 1



* Tax rate for gas and electricity is assumed to be 0%.

Since the entire facility steam demand will not be met by the HRSG, the balance of the steam can be made up with the existing boiler. The boiler is equipped with exhaust stack and blowdown heat recovery so an operating efficiency of 78-percent is assumed to account for inefficiencies, including those related to part-loading.

Additional electricity rate increases are already being proposed which will favor this project and there may be federal and/or state tax incentives and/or rebates available to assist with project. Because this appears to be a very favorable opportunity, it is strongly recommended for further consideration.

Notes:

1. Even if cogeneration is not pursued, the above analysis does suggest that the existing boiler should be considered to generate steam rather than purchasing it from the cogeneration facility.

<u>2. Steam Trap Maintenance Program (near term)</u>

Steam trap repair and replacement has been underway for some time but there are still failed traps that need replacement. Traps that fail open cause excessive venting from receivers, place unnecessary steam demands on boilers and can cause water hammer damage to piping, valves and equipment.

DA tank and reactor vessel venting is very likely due predominately to failed traps. This steam can be recovered but the best option is to identify the failed traps and repair or replace them as soon as possible. If venting persists after trap repair, other options can be considered including:

1. Use of vent steam to preheat process or other make up water.
2. Recovery of heat from condensate prior to the DA tank and reactor vessel for water preheating during warmer periods and for ventilation air preheating during cooler periods. This option is worth consideration since there appears to be no penalty for return of cool condensate to the cogeneration plant.

Based on experienced and observations during the assessment the average vent rate from the DA Tank and reactor vessel is estimated at 500-pph. Annual cost savings are estimated assuming that trap repair eliminates *all* venting. Due to the relatively large number of traps, simple return will likely range from 6-months to one year. Trap repair/replacement is recommended for immediate consideration.

Notes:

1. Until the trap failure rate is under control it is recommended that inspection and repair or replacement be performed at least twice per year. The frequency may be decreased as the number of identified failures stabilizes.
2. There are a relatively large number of traps no longer being used. If they are not already, they should be isolated and tagged to prevent unnecessary time and expense on evaluating them further.
3. Use of internal staff for trap repair and replacement is economical if they are properly trained for inspection and installation and have time to do the assessment in a timely manner. If the repair and replacement activities take an extended period of time over what an outsourced group would take, the venting losses could far outweigh any savings that would have been gained from use of internal labor.
4. It is recommended that traps be verified to match the intended use. The following can be used as guidelines for trap selection:
    a. Do not use inverted bucket traps on pressures less than 30-psig. This includes unit heaters. When possible, avoid their use all together since they can be problematic with respect to keeping “prime.”
    b. Use Float and Thermostatic traps (F&T) for process applications.
    c. Use thermostatic traps for drip legs. Avoid thermodynamic (disc) traps as they tend to fail closed causing backup of condensate and potentially damaging water hammer. Also, the operation of these traps is susceptible to changes in ambient conditions.

<u>3. Reduce Steam Demand – Minimize Steam Venting from Liqui-Movers (near/medium term)</u>

Steam venting was observed from the Johnson Liqui-Movers that accept high pressure condensate from processes that use modulating steam valves. Modulating valves atmospheric discharge pressure is required so high pressure condensate cannot simply be flashed back into the low pressure header. However, several valves were identified to be passing live steam so it is possible that the majority of the venting is live steam and not simply flash steam.

Note: Flash steam forms when high pressure, saturated water (water at the boiler point) undergoes a pressure reduction. The pressure reduction causes instantaneous boiling and formation of “flash” steam. Excessively hot condensate may result from high process condensate temperatures or leaking steam traps.

Based on observations the value of the vent steam is estimated at approximately $x per year, assuming that the majority of the venting is resulting from live steam weeping through worn valve seats. Valve seat wear that is a recurring problem may be resulting from “wire drawn” valve seats. Wire drawing can occur when condensate pools up stream of valves and then is picked up by steam as demands change. The condensate hits the valve seats at high velocity and wears the seat over time. Poor steam condensate drainage from improperly designed steam piping is often a contributing factor. This may be a large part of the Liqui-Mover venting (live steam) since numerous piping design related issues were noted. These should be addressed as necessary.

Notes:

1. The value of flash steam is uncertain because no data is available on the value of the return condensate.

<u>4. Recover Condensate Heat for Ventilation Preheating (medium term)</u>

When a boiler is used to generate steam on-site, there is usually no significant value to be gained from recovering heat from condensate before it returns to the boiler because the heat is simply added back in the process of raising steam.

However, steam is presently purchased and there appears to be no penalty for returning cool condensate to the cogeneration facility. If the heating demand required for facility ventilation air is sufficiency high, it may serve as a suitable heat sink.
Assuming that the ventilation load is sufficient to reduce the condensate temperature by 25°F on average for 4,000 hours per year, the energy savings at 80-percent condensate return is:
16,400-pph x 80% x 1-Btu/(lb-°F) x (25°F) = 328,000 Btu/hr

The equivalent steam load is:
328,000-Btu/hr ÷ 1,198-Btu/lb = 274-pph

The equipment required will be piping and a suitable heat exchanger(s) placed in the ventilation duct. The simple return could range of three to five years, but further investigation is necessary.

Note: If the facility boiler is started, the savings from the condensate heat will diminish for the most part because it will be added in the boiler. However, any benefits from reducing distribution heat losses would remain.

5. Improve Steam Line Insulation (near term)
With natural steam prices as high as is, any bare steam pipe should be insulated. The cost for the insulation assuming that there is a reasonable amount of insulation to be installed is approximately $15 to $20 per lineal foot. Approximately 100-feet of bare pipe were identified ranging in size from 2-inches to 10-inches in diameter. The simple return for insulating this length of steam pipe should range from six months to one year.

Valves and regulators such as in the boiler room, heat exchangers and flash tanks are also areas worthy of insulation. These can be insulated with “removable” insulation to allow maintenance when necessary. Removable insulation is more expensive than standard pipe insulation (per foot) but is cost effective. At least one 8-inch steam valve was but facility staff report that there are a number of others. A few suppliers are provided below for convenience but no endorsement of any particular supplier is implied.

- B&B insulation: 920.733.6086
- Advance Thermal Corporation: 630.595.5150
- Coverflex Manufacturing: 713.378.0966

Notes:

1. Generally, with high fuel costs it is recommended that it is recommended that all condensate return and steam supply piping be insulated. However, it does not appear that the present steam purchase contract provides credit for return condensate temperature. Thus, insulating condensate lines may not be a worthwhile endeavor.

Management Support and Comments:
Generally, the initial feedback on the ESA was favorable. Overall, facility staff were engaged, helpful and interested in applying the models to help screen cost reduction opportunities.

DOE Contact at Plant/Company: (who DOE would contact for follow-up regarding progress in implementing ESA results…)

Plant Contact:

Company Contact: